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UNİSYS

DATE:

May 1, 1995

FROM:

J. Lohr/311 K. Sahu/300.1 <u>K ≶</u>

SUBJECT:

Radiation Report on: OP 07A

Project:

CASSINI/CIRS

Control #: Job #: 12097 EE56288

Project part #:

JM38510/13501SGX

cc: .B. Posey/300.1 A. Sharma/311.0 OFA Library/300.1

PPM-95-149

A radiation evaluation was performed on OP 07A (OP AMP) to determine the total dose tolerance of these parts. A brief summary of the test results is provided below. For detailed information, refer to Tables I through IV and Figure 1.

The total dose testing was performed using a <sup>60</sup>Co gamma ray source. During the radiation testing, four parts were irradiated under bias (see Figure 1 for bias configuration) and two parts were used as control samples. The total dose radiation levels were 2.5, 5, 10, 15, 20, 30, 50, 75 and 100 krads. The dose rate was between 0.04 and 1.47 krads/hour (see Table II for radiation schedule). After each radiation exposure, parts were electrically tested according to the test conditions and the specification limits. listed in Table III.

All parts passed initial electrical measurements. All irradiated parts passed all parametric tests up to and including the 2.5 krad irradiation level. After the 5 krad irradiation, S/N 62, 63, 64, 66 and 67 exceeded the maximum specification limit of 2.00 nA for N\_HB\_0V, with readings ranging from 2.08 to 3.17 nA, and S/N 62, 63 and 66 exceeded the maximum specification limit of 2.00 nA for P\_HB\_0V, with readings ranging from 2.02 to 4.14 nA.

At the 10 krad irradiation level, all irradiated parts exceeded the maximum specification limit for both N\_IIB\_0V and P\_IIB\_0V, with readings ranging from 2.75 to 4.31 nA for P\_IIB\_0V and 2.87 to 3.75 nA for N\_IIB\_0V. At the 15 and 20 krad levels, the same degradation in N\_IIB\_0V and P\_IB\_0V continued, with readings ranging from 3.02 to 6.06 nA at 15 krads and from 4.91 to 8.07 nA at 20 krads.

At the 30 krad level, the same degradation in N\_IIB\_0V and P\_IIB\_0V continued. In addition, S/N 62, 63, 64, 65, 67 and 69 exceeded the specification limit of  $\pm 25.00~\mu V$  for VOS\_0V, with readings ranging from -26.0 to  $\pm 56.9~\mu V$ .

At the 50 krad level, all iradiated parts continued to exceed the maximum specification limit for N\_IIB\_0V and P\_IIB\_0V, with readings ranging from 22.6 to 36.2 nA. In addition, all irradiated parts exceeded the maximum specification limit for VOS\_0V, with readings ranging from -71.0 to 160 μV. S/N 62, 63, 65, 66 and 68 fell below the minimum specification limit of 300.0 V/mV for N\_AOL, with readings ranging from 191 to 248 V/mV. No valid readings could be obtained for S/N 64 for P\_AOL and N\_AOL at this level. S/N 62 also exceeded the maximum specification limit of 2.00 nA for IIOS\_0V, with a reading of 2.16 nA.

At the 75 krad level, the same degradation continued, with slightly increasing values. S/N 64 fell below the minimum specification limit for N\_AOL, with a reading of 173 V/mV and passed P\_AOL.

The term rads, as used in this document, means rads(silicon). All radiation levels cited are cumulative.

These are manufacturer's pre-irradiation data specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed.

At the 100 krad level, the same degradation continued. S/N 64 and 67 marginally fell below the minimum specification limit of 110.0dB for CMRR, with readings of 102 and 105 dB, respectively. In addition, S/N 64 marginally fell below the minimum specification limit of -10.0  $\mu$ V/V for +/-\_PSRR, with a reading of -10.9  $\mu$ V/V.

After annealing for 168 hours at 25°C, all irradiated parts read within specification limits for IIOS\_0V, CMRR and +/- PSRR. No other recovery was noted.

Table IV provides a summary of the functional test results and the mean and standard deviation values for each parameter for both biased and unbiased parts after each irradiation exposure.

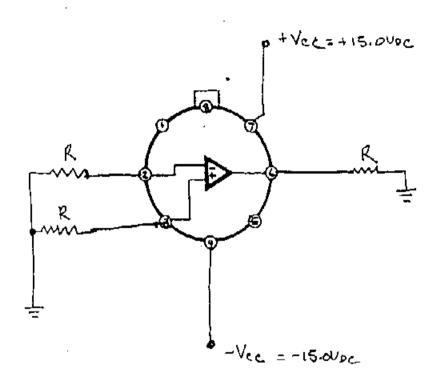
Any further details about this evaluation can be obtained upon request. If you have any questions, please call me at (301) 731-8954.

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Figure 1. Radiation Bias Circuit for OP 07A



 $R = 10k\Omega, \frac{1}{2}W$ 

### CAREPORTS/259.DOC

## TABLE I. Part Information

Generic Part Number: OP 07A\*

CASSINI/CIRS Part Number JM38510/13501SGX

CASSINI/CIRS Control Number: 12097

Charge Number: EE56288

Manufacturer: PMI

.

Lot Date Code (LDC): 9416

Quantity Tested: 10

Serial Number of Control Samples: 60, 61

Serial Numbers of Biased Radiation Samples: 62, 63, 64, 65, 66, 67, 68, 69

Part Function: Op Amp

Part Technology: CMOS

Package Style: 8-pin TOx Can

Test Equipment: A540

Engineer: T. Mondy

<sup>\*</sup> No radiation tolerance/hardness was guaranteed by the manufacturer for this part.

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# TABLE II. Radiation Schedule for OP 07A

EVENT	DATE
WOMEN TO PRESENT ALL MEASUREMENTS	04/07/95
2) 2 5 KRAD IRRADIATION (0.04 KRADS/HOUR).	04/07/95 04/10/95
POST-2.5 KRAD ELECTRICAL MEASUREMENT	04/10/95
2) & KRAD IRRADIATION (0.15 KRADS/HOUR)	04/10/95
POST-5 KRAD ELECTRICAL MEASUREMENT	04/11/95
	•
4) 10 KRAD IRRADIATION (0.29 KRADS/HOUR)	04/11/95
THE STATE OF THE PROPERTY OF T	04/12/9 <b>5</b> 04/13/9 <b>5</b>
5) 15 KRAD IRRADIATION (0.29 KRADS/100K)	04/13/95
OTHORIS AND ADDITIONAL (A SOLVE A DE/HOLD)	04/13/95 04/14/95
6) 20 KRAD IRRADIATION (0.39 KRADS/HOOK)	
POST-20 KRAD ELECTRICAL MEASUREMENT	
TO THE TANK (A LE VE A DO/HOLE)	04/14/95
7) 30 KRAD IRRADIATION (0.13 KRADS/HOOK)	04/17/95
TO THE PROPERTY OF THE PROPERT	04/18/95 04/19/95
8) 50 KRAD IRRADIATION (1.18 KRADS/1100K)	
THE STATE OF THE S	
9) 73 KRAD IRRADIATION (1.47 KRADS/1100K)	04/20/95
THE STREET OF THE STREET STREET	R)
10) 100 KRAD IRRADIA HON (1.47 KRADS/HOO	04/21/9:
POST-100 KRAD ELECTRICAL MEASUREMENT	***************************************

PARTS WERE IRRADIATED AND ANNEALED UNDER BIAS; SEE FIGURE 1.

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Table III. Electrical Characteristics of OP 07A

Unless Otherwise Specified: TA =25°C, VCC = +/- 15Vdc, VOUT=0v

EST NAME	SYMBOL	CONDITIONS	LIMI	
CEST (IZIND	011.1202		MIN	MAX
		SUPPLY CURRENT		
Plus Icc	Icc	VOUT = 0V (SEE NOTE 1)		4.0mA
Minus Icc	Icc	V <sub>OUT</sub> .= 0V (SEE NOTE 1)	-4.0mA	
		INPUT OFFSET TESTS		<u></u>
VOS 0V	$v_{IO}$	V <sub>OUT</sub> = 0V (SEE NOTE 1)	-25uV	25uV
Р ПВ ОУ	+I <sub>TB</sub>	$V_{OUT} = 0V$ (SEE NOTE 1)	-2nA	2nA
N IIIB OV	-I <sub>IB</sub>	V <sub>OUT</sub> = 0V (SEE NOTE 1)	-2nA	2nA
nos ov	IIO	V <sub>OUT</sub> = 0V (SEE NOTE 1)	-2nA	2nA
CMRR	CMRR	$V_{CM} = \pm /-13V$	110dB	
Plus PSRR	+PSRR	+Vcc =20V, 5V	-10uV/V	10uV/V
Minus PSRR	-PSRR	$-V_{cc} = -20V, -5V$	-10uV/Y	10uV/V
PSRR	±PSRR	$+V_{cc} = (4.5, 20)V, -V_{cc} = (-4.5, -20)V$	-10uV/V	10uV/V
		AMPLIFIER OUTPUT TESTS		
P VOUT 600	VOP	R <sub>L</sub> =600Ω	10.0V	
P VOUT 2K	VOP	R <sub>1</sub> =2KΩ	12.0V	
N VOUT 600	VOP	R <sub>1</sub> ,=600Ω		-10.0V
N VOUT 2K	$v_{\mathrm{OP}}$	$R_L=2K\Omega$		-12.0V
P AOL V/mV	Ays	VOUT = (0V to 10V), $R_L = 2K\Omega$	300 V/mV	
N AOL V/mV	AVS	$VOUT = (0V to -10V), R_{I} = 2K\Omega$	300 V/mV	
11102 1141		OUTPUT SHORT CIRCUIT CURRENT		
Pluse ISC	I <sub>OS(+)</sub>	VOUT=+ 45V	-65mA	
MINUS ISC	I <sub>OS(-)</sub>	VOLT = - (5V		65mA

## Note:

<sup>1.</sup> The Test Specification condition of  $V_{CM} = 0V$ , has been replaced with the condition of  $V_{OUT} = 0V$ . 2.  $R_L = 600\Omega$  was substitued for  $R_L = 1K\Omega$  due to tester limitation.

TABLE IV: Summary of Electrical Measurements after Total Dosc Exposures and Annealing for OP 07A/1

Test			Spec. Lim/2	im 2		Initial		2.5		S		0.	Total Dose E	Dose		<u> </u>	1ds) 30	_ [		50	50	50 75	50 75	50 75 100	50 75 100
#=	Parameters	Units	<b>≡</b> '	max	m)ean	ps	M # 2 F	<u>.</u>	Then I	sd	mean	sd	mean	гd		T EST	ean sd	E I	ean so mean so	sean sd mean sd mean	ean sd mean sd mean sd	sean sd mean sd mean sd mean	een sd mean sd mean sd mean sd	een st mean st mean st mean st mean	een sd mean sd mean sd mean sd
-	Plus_lcc	mÀ	0	4.0	85.1	.04	1.56	.04	1.53	.04	1.49	.04	1.44	2	ž	1.41	.41 .04	<u>.</u>	1.41 .04 1.35 .04	41 .04 1.35 .04 1.28	.41 .04 1.35 .04 1.28 .05	14I .04 1.35 .04 1.28 .05 1.23	[4] .04 [135 .04 [1.28 .05 [1.23 .05	4T .04 1.35 .04 1.28 .05 1.23 .05 1.23	[4] .04 [135 .04 [1.28 .05 [1.23 .05
۲,	Minus Icc	<b>∓</b>	-4.0	<b>•</b>	-1.57	.04	-1.55	.04	-1.52	.04	1.48	.04	-1.43	ë		-1.41	-1.41 .04	-1.41	-1.41 .04 -1.34 .04	-1.41 .04 -1.34 .04 -1.28	-1.41 .04 -1.34 .04 -1.28 .05	-1.41 .04 -1.34 .04 -1.28	-1.41 .04 -1.34 .04 -1.28 .05 -1.23 .05	-1.41 .04 -1.34 .04 -1.28 .05 -1.23 .05 -1.22	-1.41 .04 -1.34 .04 -1.28 .05 -1.23 .05
ب	VOS_0V	٦,	-25.0	25.0	-1.97	7.1	-0.20	8.0	-3.00	12	-2.00	9	-2.00	=	<u> </u>	3 -12.0	-12.0 11	-12.0	-12.0 11 -18.0 28	-12:0 11 -18:0 28 80:0	-12.0 11 -18.0 28 80.0 240	-12.0 11 -18.0 28 80.0 240 -21.0	-12.0 11 -18.0 28 80.0 240 - <b>2</b> 1.0 196	-12.0 11 -18.0 28 80.0 240 -21.0 196 -66.0	-12.0 11 -18.0 28 80.0 240 - <b>2</b> 1.0 196
4	P_ILB_0V	II.A	-2.0	2.0	1.38	.07	64.1	41	2.26	.76	3.09	.50	4.06	*	85	<u> </u>	6.13 .98	6.13	6.13 .98 12.6 2.1	6.13 .98 12.6 2.1 27.4	6.13 .98 12.6 2.1 27:4 4.0	6.13 .98 12.6 2.1 27.4 4.0 42.6	6.13 .98 12.6 2.1 27.4 4.0 42.6 3.8	6.13 .98 12.6 2.1 27.4 4.0 42.6 3.8 56.4	6.13 .98 12.6 2.1 27.4 4.0 42.6 3.8
'n	N IIB OV	Ā	-2.0	2.0	1,43	.09	1.77	.22	2,19	.40	3.05	.29	4.11	1.	is:	<del> </del>	<del> </del>	6.06	6.06 .83 12.6 1.9	6.06 .83 12.6 1.9 27.3	6.06 .83 12.6 1.9 27.3 3.5	6.06 .83 12.6 1.9 27.3 3.5 42.0	6.06 .83 12.6 1.9 27.3 3.5 42.0 3.3	6.06 .83 12.6 1.9 27.3 3.5 42.0 3.3 55.4	6.06 .83 12.6 1.9 27.3 3.5 42.0 3.3
٥	110S_0V	πÀ	-2.0	2.0	-0.05	.06	0.02	.20	0.06	.37	D. <b>Q</b>	.23	0.06		9	L	0.07	0.07	0.07 .30 -0.05 .61	0.07 .30 -0.05 .61 0.08	0.07 .30 -0.05 .61 0.08 .94	0.07 .30 -0.05 .61 0.08 .94 0.55	0.07 .30 -0.05 .61 0.08 .94 0.55 .96	0.07 .30 -0.05 .61 0.08 .94 0.55 .96 0.98	0.07 .30 -0.05 .61 0.08 .94 0.55 .96
7	СМЖЖ	Ê	110.0	,	135	2.1	561	2.5	135	2.1	138	11	143		13			137	137 4.9	137 4.9 130	137 4.9 130 B.6	137 4.9 130 B.6 /3 116	137 4.9 130 B.6 /3 116 8.0	137 4.9 130 B.6 /3 116 8.0 113	137 4.9 130 B.6 /3 116 8.0
8	Plus PSRR	J.V/V	-10.0	10. <b>0</b>	-0.24	=	-0,24	.12	-0.22 22	.12	-0.26	.15	-0.33		.16	.16 -0.32	-0.32 .19	-0.32	-0.32 .19 -0.57 .39	-0.32 .19 -0.57 .39 -0.98	-0.32 .19 -0.57 .39 -0.98 1.1	-0.32 .19 -0.57 .39 -0.98 1.1 -1.28	-0.32 .19 -0.57 .39 -0.98 1.1 -1.28 .97	-0.32 .19 -0.57 .39 -0.98 1.1 -1.28 .97 -1.23	-0.32 .19 -0.57 .39 -0.98 1.1 -1.28 .97
٥	Minus PSRR	μν/ν	-10.0	10.0	0.59	Ξ	0.59	.13	0.60	.13	0.66	.22	0.77		.22		0.69 .30	0.69	0.69 .30 0.90 .85	0.69 .30 0.90 .85 2.95	0.69 .30 0.90 .85 2.95 6.2	0.69 .30 0.90 .85 2.95 6.2 2.12	0.69 .30 0.90 .85 2.95 6.2 2.12 5.1	0.69 30 0.90 .85 2.95 6.2 2.12 5.1 0.24	0.69 .30 0.90 .85 2.95 6.2 2.12 5.1
ā	+/PSRR	hV/V	-10.0	10.0	-0.60	.17	-0.60	.19	-0,61	.20	-0.68	,25	-0.83	ı	<u>2</u> 2	.26 -0.79	-0.79 .35	-0.79	-0.79 .35 -1.15 .85	-0.79 .35 -1.15 .85 -3.31	-0.79 .35 -1.15 .85 -3.31 4.4	-0.79 .35 -1.15 .85 -3.31 4.4 -2.54	-0.79 .35 -1.15 .85 -3.31 4.4 -2.54 3.7	-0.79 .35 -1.15 .85 -3.31 4.4 -2.54 3.7 -1.97	-0.79 .35 -1.15 .85 -3.31 4.4 -2.54 3.7
=	P_VOUT_600	<	10.0	,	11.5	. <u>0</u>	11.5	10.	11.5	.01	11.5	.01	11.5		.01	.01 11.5		11.5	11.5 .01	11.5 .01 11.5 .01 11.5	11.5 .01 11.5 .01	11.5 .01 11.5 .01 11.5	11.5 .01 11.5 .01 11.5 .01 11.4 .25	11.5 .01 11.5 .01 11.5 .01 11.4 .25 11.1	11.5 .01 11.5 .01 11.5 .01 11.4 .25
22	P_VOUT_2K	<	12.0	•	14.0	<u>.</u>	14.0	Ð	14.0	9	14.0	10.	14.0		0	0 14.0	_	14.0	14.0 0 14.0 0	[4.0 0 14.0 0 14.0	14.0 0 14.0 0	[4.0 0 14.0 0 14.0	14.0 0 14.0 0 14.0 .01 (4.0 .01	14.0 0 14.0 0 14.0 .01 14.0 .01 14.0	14.0 0 14.0 0 14.0 .01 (4.0 .01
5	N_VOUT_600	<	,	-10.0	-11.2	.02	:11.2	.02	-11.2	.02	-11.2	.02	-11.3		.02	.02 -11.3	-11.3 .02	-11.3	-11.3 .02 -11.3 .02	-11.3 .02 -11.3 .02 -11.3	-11.3 .02 -11.3 .02 -11.3 .02	-11.3 .02 -11.3 .02 -11.3	-11.3 .02 -11.3 .02 -11.3 .02 -11.3 .02	-11.3 .02 -11.3 .02 -11.3 .02 -11.3	-11.3 .02 -11.3 .02 -11.3 .02 -11.3 .02
7	N_VOUT_2K	<	-	-12.0	-13.0	.0.4	-13.0	.03	.12.9	.02	-12.9	.03	-12,9		.02	.02 -12.8	-12.8 .02	-12.8	-12.8 .02 -12.8 .02	-12.8 .02 -12.8	-12.8 .02 -12.8 .02	-12.8 .02 -12.8 .02 -12.7	12.8 .02 -12.8 .02 -12.7 .03 -12.7 .02	12.8 .02 -(2.8 .02 -12.7 .03 -12.7 .02 -12.7	12.8 .02 -12.8 .02 -12.7 .03 -12.7 .02
5	P_AOL/3	V/m V	300.0		5000	385	4359	309	3932	179	3434	208	2628		231	231 2495	2495 159	2495	2495 159 2285 180	2495 159 2285 180 1238	2495 159 2285 180 1238 229	2495 159 2285 180 1238 229 1050	2495 159 2285 180 1238 229	2495 159 2285 180 1238 229 1050 456 1305	2495 159 2285 180 1238 229 1050 456
6	N_AOL /3	۷m/	300.0	, ]	5501	427	4999	527	4748	419	4030	451	2445	7	796	96 1755	_	1755	1755 561	1755 561 742 194 272	1755 561 742 194 272 112	1755 561 742 194 272	1755 561 742 194 272 112	1755 561 742 194 277 112 174 31 157	1755 561 742 194 272 112 174 31
17	Plus_iSC	m.A	-65.0		-27.0	.35	-30.0	.37	-26.7	.38	-26.6	.29	-26.3	١. ا	25	25 .26.3	-26.3 .33	-26.3	-26.3 .33 -25.9 .36	-26.3 .33 -25.9	.26.3 .33 .25.9 .36 .25.3 .52	-26.3 .33 -25.9 .36 -25.3	.26.3 .33 -25.9 .36 -25.3 .52 -24.9 .70	.26.3 .33 -25.9 .36 -25.3 .52 -24.9 .70 -24.5	.26.3 .33 -25.9 .36 -25.3 .52 -24.9 .70
<b>5</b>	Minus_ISC	Am	,	65.0	37.1	.58	37.0	.62	36.4	.69	36.1	.61	35.6	i	.60	.60 35.5		35.5	35.5 .76 34.8 .83	35.5 .76 34.8	35.5 .76 34.8 .83 33.7 1.1	35.5 .76 34.8 .83 33.7	35.5 .76 34.8 .83 33.7 1.1 33.2 .94	35.5 .76 34.8 .83 33.7 1.1 33.2 .94 32.7	35.5 .76 34.8 .83 33.7 1.1 33.2 .94

# Notes:

- 1/ The mean and standard deviation values were calculated over the four biased and two unbiased parts included in this table. irradiated in this testing. The control samples remained constant throughout the testing and are not
- 2/ These are manufacturer's pre-irradiation data sheet specification limits. No post-irradiation limits were provided by the manufacturer at the time these tests were performed
- 3/ The mean and standard deviation for this parameter at the 50 krad level is calculated for seven samples.

Radiation-sensitive parameters: P\_IIB\_0V, N\_IIB\_0V, VOS\_0V, P\_AOL, N\_AOL, IIOS\_0V, CMRR and +/- PSRR.